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ABSTRACT

Double-entry expectancy tables are used to make admissions, guidance, or employment decisions based on two predictors. Examples of their use in showing relationships between high school and college performance are explained. The advantages of double-entry expectacy tables given are: (1) relative simplicity of preparation requiring no formal statistical training; (2) ease in understanding; and (3) simultaneous display of relationships among two predictors and a criterion. Questions concerning the construction and use of these tables are answered. Directions are given for constructing a double-entry expectancy table: (1) decide what groupings are to be used for scores on each of the predictors and for scores, ranks or ratings on each criterion; and draw the appropriate grid; (2) make a tally mark for each person in the proper cell for his test scores and criterion rating; (3) when all cases have been tallied, add the number of tallies in each cell and record the sum in that cell; (4) to the right of each row, record the total of the entries in that row; (5) below each column, record the total for that column, using separate totals for each criterion category; and (6) compute percents to answer the various questions one may ask. (KM)

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DOUBLE-ENTRY EXPECTANCY TABLES

ALEXANDER G. WESMAN

JOHNNY gets good test scores, but his grades are just about passing. Mary does well in class, but her scores on tests aren't very good. Frank scores high on tests of numerical ability, but he is only average on verbal ability tests. Anne rates very high on knowledge of her job, and she scores above average on a test of supervisory practices.

The counselor or personnel officer ordinarily has more than one kind of information available for any student or applicant with whom he is concerned. In one way or another, he must make a judgment which takes into account more than a single fact. For example, it is well known that scholastic aptitude test scores are useful predictors of college success. It is also a fact that how a student fared in high school courses is useful information for estimating the likelihood of his success in college. A counselor has access to both kinds of information for each student in his school. College admissions officers require both kinds of information on candidates. And, of course, industry obtains more than one relevant fact about each prospective employee.

How is the information to be used? Should the counselor discourage from pursuing a college career the student whose test scores are good, but whose course grades are mediocre? What about the student whose course grades are superior, but whose test scores are less promising—should he be encouraged to try for higher education? How much do good test scores compensate for an indifferent academic record? Is the student who is a little above average on both test scores and grades a better bet than one who is very superior on one of these measures but a little below average on the other?

These questions are being answered daily—by counselors, by admissions office staffs, by personnel officers. They may not be answered consciously and stated explicitly, but each decision made is in fact an active response to these questions. Sometimes the weight assigned to each characteristic or ability is systematically determined. Often the judgments are made intuitively, and inconsistently. In a school system with several counselors, two students presenting similar patterns of scores and grades may have quite different advice offered them. In a business firm, the employment interviewer may weight experience more heavily than he does test scores for an applicant this week, and less heavily for another applicant next week. All too frequently, the person making the judgment is not aware that he is combining the available information in different ways for different counselees or applicants. Clearly, if reliable judgments are to be made, a more nearly uniform method of handling the available facts is highly desirable.

It is important also that these judgments be readily communicable. If the student is to participate in an informed way in the counseling process, the counselor needs to be able to make clear to the student the basis for his predictions—how the interplay of facts leads to the suggested course of action. The personnel man, too, should be prepared to tell how and why he arrived at a decision to hire or not to hire. Accordingly, a method is called for which enables the counselor or personnel officer to be objective and consistent in his assignment of weights to different pieces of information and which facilitates communicating to others (student or parent, principal or office executive) the rationale underlying the advice or decision.

There are statistically sophisticated techniques, such as multiple regression, which are entirely appropriate as ways of combining data according to optimal weights. These techniques ensure systematic judgments, and they are certainly

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psychometrically acceptable. They do not, however, represent a ready means of communication with students, parents, or bosses; the techniques are just not comprehensible to the laymen to whom the results are being translated. What is needed, then, is a device which will not only present the facts which form the basis for prediction, but which will also make it easy to communicate those facts. Such a device is the "double-entry expectancy table."

The more familiar simple expectancy table is one which shows the relationship between a single predictor and some criterion of performance; e.g., IQ vs. grade in English or *Mechanical Comprehension Test* score vs. foreman's rating. The simple expectancy table is a very useful device. Its chief limitation is that it displays the predictive value of only one predictor at a time. Few admissions, guidance, or employment decisions are made on the basis of only one relevant predictor; many more such decisions are based primarily on two predictors. In such instances, the double-entry expectancy table will be found highly useful.

As one illustration of the construction and contribution of double-entry expectancy tables, we have utilized data from the records of college freshmen at a large midwestern university. For each student there were available rank in high school class and scores on the *College Qualification Tests (CQT)*: first semester grade-point averages[1] served as the criterion of success to be predicted. There were 1340 men students and 1053 women for whom complete data were supplied by the university. To make the data manageable for our purposes, the high school ranks, test scores, and college grade-point averages were each grouped into three categories: high, middle, and low. Table 1 shows these groupings.

TABLE 1

MEANING OF GROUP DESIGNATIONS

Group	H.S. Rank	CQT Total Score	Coll. GPA
High	70-99 %ile	70-99 %ile	A & B
Middle	30-69 %ile	30-69 %ile	C
Low	0-29 %ile	0-29 %ile	D & F

Thus, a high school rank of the 70th percentile or better was called "high," ranks from the 30th to the 69th percentile were called "middle," and ranks from the 29th percentile down were called "low." *CQT* Total scores were similarly classified. College grade-point averages were grouped by letter grade: A and B as the high group, C as the middle, and D and F as the low.

If we construct simple expectancy tables using these categories, we have the data shown in Tables 2 and 3 for the men and in Tables 4 and 5 for the women.

The number appearing in each cell is the per cent of students in each predictor category row who earned the indicated average grade. Table 2, for example, shows that among the men who scored "high" on *CQT* Total, 16 per cent earned grade averages of D or F, 45 per cent earned C's, and 39 per cent earned B

[1]For ease of reading, letter grade equivalents of the grade-point averages are used in the tables.

or A averages. These results are in sharp contrast to the performance of those men who scored "low" on the test: 80 per cent with grades of D or F, 19 per cent with C's, and only one per cent with a grade of A or B. Similar expressions of the probability of earning satisfactory grades are recorded in the cells of Tables 3, 4, and 5.

Obviously, these data are meaningful and useful—to student, counselor, parent, and admissions officer alike. They reveal that despite the considerable relationship between high test scores and college success, some men and women in the top test-score group do fail; they reveal also that despite heavy adverse odds, some low-scoring men and women do pass—though few achieve distinguished grades. The information may well serve to motivate both kinds of student at the same time that it reports to the admissions officer the odds for or against success of any candidate. Each table contributes to wisdom in guidance or selection procedures.

TABLE 2

RELATIONSHIP BETWEEN CQT TOTAL SCORE AND COLLEGE GPA
Men (N = 1340)

CQT Total	Grade Point Average			
	D & F	C	A & B	
High	16	45	39	100
Middle	43	50	7	100
Low	80	19	1	100

TABLE 3

RELATIONSHIP BETWEEN HIGH SCHOOL RANK AND COLLEGE GPA
Men (N = 1340)

H.S. Rank	Grade Point Average			
	D & F	C	A & B	
High	19	49	32	100
Middle	52	41	7	100
Low	72	27	1	100

TABLE 4

RELATIONSHIP BETWEEN CQT TOTAL SCORE AND COLLEGE GPA
Women (N = 1053)

CQT Total	Grade Point Average			
	D & F	C	A & B	
High	6	43	51	100
Middle	25	60	15	100
Low	57	41	2	100

TABLE 5

RELATIONSHIP BETWEEN HIGH SCHOOL RANK AND COLLEGE GPA
Women (N = 1053)

H.S. Rank	Grade Point Average			
	D & F	C	A & B	
High	14	52	34	100
Middle	50	47	3	100
Low	64	36	—	100

Note.—Entries in Tables 2-5 are in percentages.

It is appropriate to consider, however, how judgments might differ if *both* test score and rank in class were taken into account for each student. Does a good test score compensate for poor previous academic performance? How much are a student's chances of success enhanced if, although he is in the low group on rank in high school, he scores high on the test? Suppose John Jones is at the 78th percentile on test score and at the 52nd percentile on high school rank. The first fact suggests his chances of earning a grade-point average of C or better are 84 per cent; the second fact indicates his chances to be 48 per cent. The difference is dramatic; it would clearly be more satisfying as well as more accurate to have a statement which combines these probabilities. We can accomplish this by preparing double-entry expectancy tables, as shown below. Table 6 presents probabilities associated with test score and class rank simultaneously, for men; Table 7 presents a parallel display for women.

The data in Tables 6 and 7 reveal the predictions which can be made when *CQT* test score and high school rank are considered jointly, rather than singly. Thus, from Table 2 we learn that 16 per cent of the men who scored high on *CQT* failed to earn a better grade than D or F; from Table 3, we see that 19 per cent of the men who were admitted with high standing in high school rank similarly failed to earn a grade average higher than D.

Table 6, however, informs us that if the male freshman came from the top group of his high school class *and* scored high on *CQT*, the likelihood that he will earn a grade-point average lower than C is reduced to a mere 10 per cent. On

the other hand, if he scored high on *CQT* but came from the low group of his high school class, his likelihood of earning no better than a D or F grade-point average is a sizable 47 per cent.[2] Let us return now to John Jones, who was average in high school rank but scored high on *CQT*. If we predicted solely on the basis of his rank in school (Table 3), we would estimate his chances of earning an average grade higher than D at 48 per cent. Table 6 reveals that if we also consider his high score on the test, we raise our estimate to a more promising 63 per cent (15 per cent for A or B plus 48 per cent for C).

[2]As one would expect, relatively few students in the bottom ranks in high school score high on *CQT;* in this instance, the 47 per cent represents eight men out of seventeen admitted with low rank and high score.

Table 7 shows a double-entry expectancy table for the women's data reported in Tables 4 and 5. It, too, is a statement of joint probabilities, taking into account both high school record and test score. Thus, if Mary Smith came from the middle group on high school rank we would

TABLE 6

RELATIONSHIP BETWEEN CQT TOTAL SCORE, HIGH SCHOOL RANK, AND COLLEGE GRADE POINT AVERAGE

Men (N = 1340)

CQT Total Score		High School Rank					
		Low		Middle		High	
High	GPA	A & B	6	A & B	15	A & B	45
		C	47	C	48	C	45
		D & F	47	D & F	37	D & F	10
Middle	GPA	A & B	0	A & B	4	A & B	10
		C	33	C	44	C	58
		D & F	67	D & F	52	D & F	32
Low	GPA	A & B	0	A & B	2	A & B	0
		C	3	C	21	C	29
		D & F	97	D & F	77	D & F	71

TABLE 7

RELATIONSHIP BETWEEN CQT TOTAL SCORE, HIGH SCHOOL RANK, AND COLLEGE GRADE POINT AVERAGE

Women (N = 1053)

CQT Total Score		High School Rank					
		Low		Middle		High	
High	GPA	A & B	0	A & B	6	A & B	57
		C	100	C	70	C	39
		D & F	0	D & F	24	D & F	4
Middle	GPA	A & B	0	A & B	4	A & B	19
		C	33	C	50	C	64
		D & F	67	D & F	46	D & F	17
Low	GPA	A & B	0	A & B	0	A & B	4
		C	22	C	30	C	55
		D & F	78	D & F	70	D & F	41

estimate her chances of earning an average grade better than D at 50 per cent (Table 5); if, however, her score on *CQT* was high we would raise the probability estimate to 76 per cent. The additional reassurance represented by the higher estimate might be crucial to Mary's willingness to undertake a college education—at least, at this institution. It might also make her, in the eyes of the admissions officer, a superior candidate rather than a mediocre one. It is noteworthy, too, (Table 6) that there were seventeen men admitted whose low high school rank would have predicted their earning an average grade of C or better as 28 per cent; their high scores on *CQT* force reappraisal of these odds—nine of the seventeen with low high school rank but high *CQT* score earned at least C grade averages. Test information *can* make a difference.

The development of double-entry expectancy tables separately for men and women permits an interesting observation, one which relates to the qualities which favor women over men in the obtaining of grades. While this phenomenon may be observed by comparison of several analogous cells in Tables 6 and 7, it is perhaps most dramatically displayed by the figures in the lower right-hand cells, which report the expectancies for students who were in the top group of their high school class, but who scored low on the *College Qualification Tests.*

Among men who were admitted from this group, 71 per cent (twenty out of twenty-eight) failed to achieve a satisfactory grade; and none of those who did manage to pass earned higher than a C grade-point average. For women, however, the figures are quite different; of seventy-seven low-scoring, high-rank-in-class females who were admitted, only thirty-two (41 per cent) failed to achieve a satisfactory grade-point average—55 per cent achieved successfully and another four per cent even earned an A or B average. It appears that whatever characteristics were effectively employed by these women to earn good grades in high school—in spite of low scholastic aptitude (as measured by tests)—stood them in equally good stead in college.[3]

Another illustration of the usefulness of double-entry expectancy tables has been drawn from an industrial study. A large electronics firm administered a series of tests to a group of eighty-two computer service representatives. Among the tests used were the *Mechanical Comprehension Test*, Form CC *(MCT)*, and the *Wesman Personnel Classification Test (PCT)*. The immediate supervisors of these representatives assigned ratings of Highly Successful and Less Successful to these men. To observe the relationship between scores on the tests and the performance rating, a double-entry expectancy table was prepared. The company decided on cutoff scores for each of these tests on the basis of this study and of their local personnel needs. The chosen cutoff scores were 41 for the *Mechanical Comprehension Test* and 38 for the *Wesman Personnel Classification Test*. Table 8 shows the results of these procedures.

The table shows that among the currently employed computer service men, fourteen had scored 41 or above on *MCT* and 37 or below on *PCT*. Of these fourteen, ten were rated Highly Successful, and four were rated Less Successful. The other three cells show the placement of the remaining men according to their scores and ratings.

TABLE 8

RELATIONSHIP BETWEEN PCT TOTAL SCORE, MCT SCORE, AND SUCCESS RATINGS

Computer Service Representatives (N = 82)

MCT Score	PCT Score: 37 and below		PCT Score: 38 and above	
41 and above	High	10	High	16
	Low	4	Low	1
40 and below	High	19	High	6
	Low	25	Low	1

The basis for the selection of the particular cutoff scores is revealed by the table. Of the eighty-two men studied, fifty-one were rated in the high group, thirty-one in the low. Applying the cutoff score on *MCT* alone, twenty-six high-success men and five low-success are included in the upper group. Applying only the *PCT* cutoff score, twenty-two high men and two of the low are included in the upper group. When both cutoff scores are employed, only one of the less successful men remains as compared with sixteen of the highly rated.

The decision of the company in this case was apparently to minimize the number of less successful men, at the cost of excluding many of the potentially highly successful men. It is conceivable, certainly, that in another situation the decision reached might be to exclude only those who were below *both* cutting scores: this would accept thirty-two (10+16+6) of the high group while rejecting twenty-five (lower left cell) of the total of thirty-one rated less successful. The point is, of course, that the expectancy table does

[3]The writer is reminded of a limerick he first saw twenty-five years ago in the book on measurement by C. C. Ross:

There was a young girl at McMaster
Whose head was alfalfa and plaster
But she looked like a queen
And she smiled at the dean
So he graded her paper—and passed her.

not prescribe the decision; it merely displays the information in a form which makes the consequences of a decision readily visible.

Table 9 illustrates the use of a double-entry expectancy table at an earlier educational level. The students were 294 boys and girls in the seventh grade of an eastern junior high school. These students had taken the *Academic Promise Tests (APT)* in February, at the beginning of a course in science. At the end of the course, the grades they earned included 31 A's, 65 B's, 123 C's, 40 D's, and 35 E's. (Note that these refer to *numbers* of students, not to per cent.) The table has been constructed according to raw scores on *APT* Numerical and *APT* Language Usage test categories. The numbers in the cells show how many students in each of the two-test category groups earned each of the five grades. Thus, the number "5" at the top of the upper right-hand cell indicates that five students whose *APT* Numerical score was 40 or higher and whose *APT* Language Usage score was also 40 or higher earned A's in their science course.

Several noteworthy facts are reported in this table:

1. Only two of the seventy-five students who got D or E grades scored above 29 on either test; neither of the two exceeded 29 on *both* tests.
2. More than half the students who were graded E (19 of 35) scored in the lowest group on *both* tests.
3. Only one student in the lowest-scoring group on both tests earned an A; only two earned B's.
4. Perhaps most significantly for purposes of our present discussion, of two hundred five students who scored 29 or below on *APT*-N, seventy-four

TABLE 9

RELATIONSHIP BETWEEN APT-N AND APT-LU SCORES, AND GRADES IN SCIENCE
Seventh Grade Students (N = 294)

Numerical Score	Grade	Language Usage Score: 19 & below	20-29	30-39	40 & above	Row Total
40 & above	A			6	5	11
	B			6	2	8
	C		2	1	1	4
	D					
	E					
30-39	A	1	1	4	5	11
	B		7	12	10	29
	C	2	8	12	3	25
	D					
	E	1				1
20-29	A	2	3		1	6
	B	3	7	6	8	24
	C	9	25	17	2	53
	D	8	6	1		15
	E	3	7			10
19 & below	A	1	1	1		3
	B	2	2			4
	C	22	18	1		41
	D	19	6			25
	E	19	4	1		24
Column Total (by grade)						Grand Total
	A	4	5	11	11	31
	B	5	16	24	20	65
	C	33	53	31	6	123
	D	27	12	1		40
	E	23	11	1		35

received grades below C. But of these same two hundred five students, thirty-eight scored at 30 or above on *APT*-LU and thirty-six of these thirty-eight earned grades of C or better. Similarly, good scores on *APT*-N compensated for low scores on *APT*-LU. Thus, having simultaneous information on scores from *both* tests may appreciably influence prediction of the student's probable performance in the science course.

The advantages of double-entry expectancy tables are:

1. They are relatively simple to prepare: no formal statistical training is necessary.
2. They are relatively simple to understand; the reader needs a minimum of explanation.
3. They permit simultaneous display of relationships among two predictors and a criterion.

There are, of course, limitations to tables of this kind, as there are to almost any aids available to the test user; there are also questions concerning the construction and use of these tables which deserve attention. The following section reflects some of these matters.

Q. Is there some number of test-score or criterion categories which is optimal?

A. No. The table should display information in such a way as to be (1) most revealing to the constructor who wishes to analyze his data and/or (2) most readily and correctly understood by the reader for whom it is intended. The same data may be displayed quite differently depending on one's purpose. Thus, the admissions officer may be interested primarily in the applicant's likelihood of persisting successfully to the earning of a degree. In this instance, he would tabulate the data for test scores against a two-category criterion: graduated—did not graduate. The counselor, on the other hand, may want to be able to show a counselee the chances of earning a C, a B, or an A grade average at the state university, as against comparable probabilities at the community college in his city. In this case, he might well use a larger number of criterion categories.

Q. Are there not other considerations in deciding on how many categories to use?

A. Yes, indeed. Perhaps one of the most important of these considerations is the number of cases involved. Where there are relatively few cases available for study, it is self-deceiving to spread them over a large number of cells. The reliability of the data is proportional to the number of cases. A cell which contains one or two or three individuals cannot properly inspire the same confidence in interpretation as does one with ten, twenty, or thirty. In Table 9, for example, the fact that one student in the lowest-scoring group on both tests (lower left-hand cell) earned an A in the course promises little with regard to the expectation of similarly scoring students in the following year; there might be two students with A's then, or none. In the same cell, the fact that nineteen students earned E and another nineteen earned D permits reasonable confidence that next year's low scorers will have difficulty in excelling in the science course. The larger the number of cases, the more are we entitled to confidence in predictions based on the data.

Q. Is it preferable to enter the number of individuals in each cell or to use per cents?

A. This, too, depends in part on the number of individuals included. If the number is large, it is often easier for the reader to grasp the relationships among per cents than to work out the various ratios with differing totals from column to column or row to row. However, when the number of individuals is small, per cents tend to exaggerate the reliability of the data and thus delude the reader. Two cases out of five, or eighty cases out of two hundred, each will yield 40 per cent; the former is not very dependable for prediction of performance by future groups; the latter is worthy of greater confidence. (Of course, if there are *very* few cases in the total group, it might be best not to construct a table at all.)

Q. What is the difference between an "expectancy" table and an "experience" table?

A. No difference, really. The same table may be referred to as an "experience" table because it records the performances of people in the past. Since the data are ordinarily employed to predict future performance, the term "expectancy" has found popular acceptance.

Q. Is prediction of future performance the only purpose for which expectancy tables can be used?

A. Prediction is the primary purpose; however, there are corollary possibilities. One of these, for example, is to identify instances in which the individual's performance in the course or on the job outstripped or fell well below that of his peers on the test or on other predictors. Attention to individuals who differ markedly is sometimes rewarded by directing attention to important relevant characteristics which might otherwise be missed. Another benefit which may be derived from the study of a double-entry expectancy table was alluded to earlier: it may show whether low standing on one predictor can be compensated for by higher standing on another or whether good performance on both tests is

to be required. In the *CQT* tables above, it was shown that good test scores did compensate for low high-school rank among the men.

Q. Are double-entry expectancy tables useful for multiple cutoff procedures?

A. Very much so. Multiple cutoff procedures are those in which minimum (critical) scores are stipulated on two or more tests or other predictors. If predictors are studied one at a time, the relevance of other scores as potential compensating agents is likely to be missed. The very stucture of the double-entry expectancy table emphasizes the combined utility of the predictors—and may suggest that minimum scores be flexible rather than rigid, and admit several score combinations as acceptable.

Q. When correlation coefficients are offered as evidence of the validity of one or more predictors, the need for repeating the study (cross-validation) is often stressed. Does this need apply to expectancy tables also?

A. Very much so. Validity is always specific to the group for which it has been studied. Whether the validity is reported in terms of coefficients (simple or multiple) or expectancy tables (simple or double-entry), the effects of chance must be reckoned with. Accidental characteristics of the particular individuals studied and imperfect reliability of predictors and criteria influence the data in any single study—and the smaller the number of individuals involved, the greater is the probable influence of extraneous factors. Replication of validity studies and accumulation of larger numbers of cases for study permit greater degrees of confidence in the data, and in decisions based on the data, than is otherwise warranted.

Q. Can expectancy tables be devised to account for more than two predictors?

A. Yes, but. Tables could be devised to incorporate data from three, and perhaps even more, predictors. There is considerable doubt, however, that preparing such tables would be genuinely useful. One of the most attractive features of expectancy tables is that their message is readily discernible. The complexity of tables devised to display more than two predictors is likely to confuse the reader more than to inform him. If a central purpose of expectancy tables is to be communication with those who are unfamiliar with psychometric data, one ought probably to recognize that a three-variable relationship (two predictors and one criterion) is about as far as one should go.

To summarize, the double-entry expectancy table can be a useful device for analyzing prediction data and for communicating their meaning to uninitiated but interested readers—students, parents, colleagues. Like any device, it has limitations of which both designer and user should be aware. Skillfully employed and wisely read, it can contribute much to the better understanding of the prediction process.

How to Construct a Double-Entry Expectancy Table

1. Decide what groupings are to be used for scores on each of the predictors and for scores, ranks, or ratings on the criterion. Draw the appropriate grid.

In the illustrative table, test A scores are sorted into four groups (A_1, A_2, A_3, A_4), test B scores into three groups (B_1, B_2, B_3), and criterion data into two (C_1, C_2).

2. Make a tally mark for each person in the proper cell for his test scores and criterion rating. In the illustrative table, a person in the highest group on test A, the middle group on test B, and the upper group on the criterion would be tallied in the cell designated $A_1B_2C_1$; a person whose score on test A was in the lowest group, (A_4), whose score on test B was also in the lowest group, (B_3), and who was low on the criterion (C_2) would be tallied in the cell designated $A_4B_3C_2$ (lowest cell at the left).

3. When all cases have been tallied in the correct cells, add the number of tallies in each cell and record the sum in that cell. For ease of reading, it may be desirable to draw a new grid, and transfer the sums to the cells of the new grid.

4. To the right of each row, record the total of the entries in that row.

5. Below each column, record the total for that column; record separate totals for each criterion category. (Since the illustrative table has two criterion categories, i.e., C_1 and C_2, two totals are recorded below each column.)

6. The basic table is now complete. At this point, per cents may be computed to answer various questions one may ask. If one wished to know what proportion of the persons who

were in the highest group on both tests were low on the criterion, he would compute the ratio of the number in cell $A_1B_1C_1$ to the sum of the numbers in cells $A_1B_1C_1$ and $A_1B_1C_2$. Thus, if there were twenty-three people in cell $A_1B_1C_1$, and two people in cell $A_1B_1C_2$, the proportion of low criterion persons would be two out of twenty-five, or eight per cent.

As a second example, one might ask: "What are the chances that an individual in the lowest scoring group on A and the middle B group (A_4B_2) would rate high on the criterion?" If we add the numbers in cells $A_4B_2C_1$ and $A_4B_2C_2$, we may consider that sum to be 100 per cent; the proportion in the upper cell ($A_4B_2C_2$) then indicates the probability that an individual with such scores will achieve high rating on the criterion. Thus, if there were five individuals in cell $A_4B_2C_1$ and fifteen in cell $A_4B_2C_2$, the chances would be five out of twenty, or 25 per cent.

It is also possible to analyze performances of combined groups. Thus, we might wish to know the proportion of those who scored in the *two* bottom categories (A_3 and A_4) on test A and in the *two* bottom categories (B_2 and B_3) on test B who nonetheless achieved the high rating (C_1) on the criterion. We would then add up the entries in the eight cells in which these individuals have been tallied: $A_3B_3C_1$, $A_3B_3C_2$, $A_3B_2C_1$, $A_3B_2C_2$, $A_4B_3C_1$, $A_4B_3C_2$, $A_4B_2C_1$, and $A_4B_2C_2$. The sum of these entries would be considered as 100 per cent. The number of low scorers who earned high criterion ratings would be obtained by adding up the entries in the four of the above cells designated C_1. The ratio of this sum to the total of the eight cells would be the sought-for proportion.

Obviously, there are a large number of such questions which may be addressed to a table of this kind, and much valuable insight to be gained by performing the various possible analyses.

ILLUSTRATIVE DOUBLE-ENTRY EXPECTANCY TABLE

	B_3	B_2	B_1	TOTALS
A_1	$A_1B_3C_1$	$A_1B_2C_1$	$A_1B_1C_1$	A_1C_1
	$A_1B_3C_2$	$A_1B_2C_2$	$A_1B_1C_2$	A_1C_2
A_2	$A_2B_3C_1$	$A_2B_2C_1$	$A_2B_1C_1$	A_2C_1
	$A_2B_3C_2$	$A_2B_2C_2$	$A_2B_1C_2$	A_2C_2
A_3	$A_3B_3C_1$	$A_3B_2C_1$	$A_3B_1C_1$	A_3C_1
	$A_3B_3C_2$	$A_3B_2C_2$	$A_3B_1C_2$	A_3C_2
A_4	$A_4B_3C_1$	$A_4B_2C_1$	$A_4B_1C_1$	A_4C_1
	$A_4B_3C_2$	$A_4B_2C_2$	$A_4B_1C_2$	A_4C_2
TOTALS	B_3C_1	B_2C_1	B_1C_1	
	B_3C_2	B_2C_2	B_1C_2	